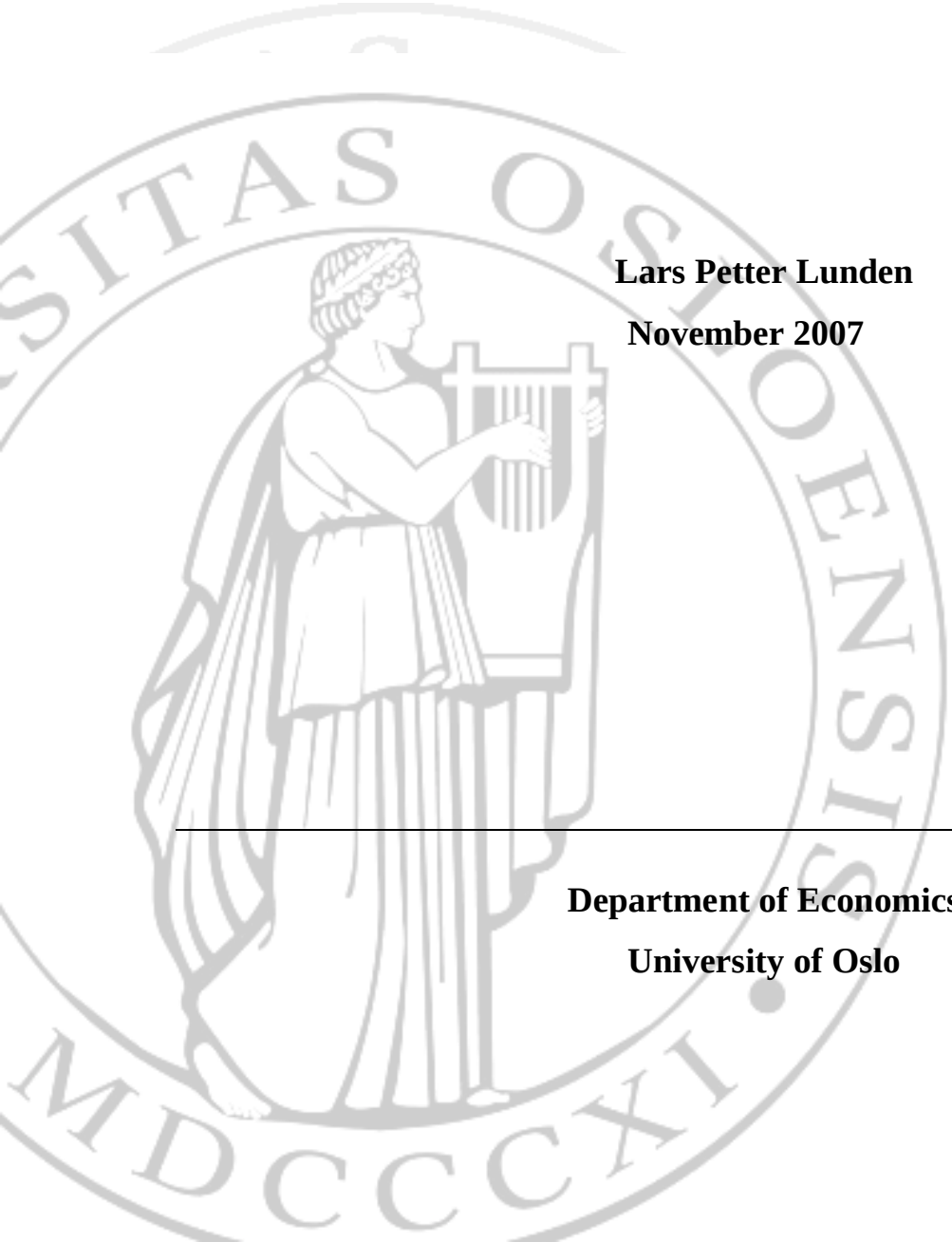
Master thesis for the Master of Economics degree

The Brazilian Stock Market

Extending the three-factor model of Fama and French to capture the variation of Brazilian stock returns



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Preface

This Master thesis is written with Bernt Arne Ødegaard as Supervisor. He has been very accessible throughout the work process and has guided the thesis in the right direction as well as remarking errors. I would like to express my gratefulness for his efforts. Moreover, I would like to thank the University of Sao Paulo for giving me access to the Economatica database where the data was collected. Finally, I am grateful for the inspiring thoughts of Professor Roy Martelanc at the University of Sao Paulo in an early stage of the process.

Oslo, 11. November 2007

Summary

Brazil is a country which has experienced increased attention from the rest of the world in the recent years. The BOVESPA (Bolsa de Valores de São Paulo) is the largest stock exchange in Latin America and the economy is in a better state than ever. The economy has experienced a growth rate of about 4 % and the macroeconomic conditions are generally improving. Almost every multinational company has operations in Brazil. Even Norwegian companies such as Statoil and Hydro are now involved in one of the most exiting emerging markets in the world. The stock market has experienced a recent boom and almost ten-doubled its market capitalization between 2002 and 2007. In the same period the participation of international investors rocketed.

However, Brazil does not have a developed economy, both the macroeconomic conditions and the stock market are more volatile than those of more developed countries. This raises concerns about the predictability of Brazil's stock market for the investors. There have been some studies about the development and predictability of the Brazilian stock market, but these are by no means conclusive.

The CAPM (Capital Asset Pricing Model) is arguably the most important and most frequently tested model within finance. Basically, the CAPM relates the excess return on an asset to the excess return on the market portfolio. An asset has a given level of risk which can be divided into two parts, systematic and unsystematic risk. Systematic risk is the market risk which influences a large number of assets. Unsystematic risk is what can be diminished by diversifying your investments, it is the risk exclusive to the asset. Thus, if you hold a large amount of stocks in your portfolio, the unsystematic risk of the assets will be "netted out". There is no reward holding unsystematic risk since it can be diversified away, thus priced risk is proportional only to systematic risk. The CAPM introduces the beta term which measures an assets risk in relation to the market portfolios risk. An asset, or a portfolio of assets, can be riskier or less risky than the market portfolio, but in the CAPM world it is always efficient since diversifiable risk has been eliminated. I.e., the reward you get is proportional to the risk you are willing to take.

Unfortunately, empirical tests have shown that the world of asset prices is not that simple. Numerous studies have focused on the power of the CAPM to explain common variation of stock returns and the general conclusion is that it does not work very well. A number of studies have suggested that other firm characteristics than the beta term could provide explanatory power for asset returns. Especially firm size and a firm's book-to-market (B/M) ratio have been shown to have systematic relationships with stock returns. Perhaps the most important of these studies have been those of Fama and French (1992 and 1993). They introduce the three-factor model which incorporates factors reflecting the influence of firm size and the B/M ratio on stock return variation. Fama and French (1993) sort stock returns on size and on the B/M ratio. The stocks are sorted in two equal portfolios on size and on three portfolios at the 30^{th} and 70^{th} percentiles on the B/M ratio. Six portfolios are independently constructed at the intersection of these. The factors are the SMB (Small minus Big) and HML (High minus Low) factors. The SMB is the average return on the small portfolios minus the average return on the big portfolios and the HML is the average return on the high B/M ratio portfolios less the return on the low B/M ratio portfolios. These factors are designed to capture the additional return investors have historically received investing in stocks with low market capitalization and a high B/M ratio. A positive premium for both small size and a high B/M ratio is found in Fama and French's paper (1993). It is important, however, to remember that these factors do not build on theory, they are rather arbitrarily constructed *ad hoc* factors that work, in Fama and French's words, "surprisingly well" explaining variation of stock returns.

The object of this paper is to attempt to answer if the three-factor model and an international six-factor model yield good explanatory power for the common variation of stock returns for stocks on the BOVESPA between 1995 and 2006. These models can be used in applications where it is needed to calculate expected returns. This includes cost of capital calculations, portfolio performance benchmarks and risk analysis.

The contribution to the existing literature will be twofold. First, the three-factor model will be extended to an international six-factor model incorporating proxies for world factors from the U.S. market. This is done to check for international influence on the Brazilian equity market. The U.S. is chosen because of its assumed relatively large economic integration with Brazil

compared to other developed markets. Second, the approach to forming the SMB and HML factors will be different to that of Fama and French (1992). By grouping the stocks dependently, first according to size and then according to the B/M ratio, we will get portfolios with an equal number of securities (give or take one). This approach is chosen because of the relatively few stocks listed on the BOVESPA. By utilizing Fama and French's methodology, we will at times get very few stocks in some portfolios, thus giving a more uncertain description of the market.

These problems will be addressed by regressing nine excess portfolio returns on the excess market return and the SMB and HML factors using Microsoft Excel's statistical tools. First we run a number of regressions using Brazilian data only. Then, we extend the model to the international six-factor model where the additional U.S. factors will be utilized. The relative applicability of the different models is discussed comparing the R-squared measure and the average of the absolute values of the intercepts. Moreover, the significance of the slope coefficients for excess market return and the SMB and HML factors will be investigated by studying their p-values.

We find that the domestic three-factor model works better than the CAPM model explaining variation of stock returns. However, the results found here are less convincing than those of the U.S. market. We also find that the portfolio construction applied here gives a better description of the Brazilian stock market since the negative relationship between size and return and the positive relationship between the B/M ratio and return are confirmed.. Moreover, extending the model from the domestic three-factor to the international six-factor model improves somewhat the explanatory power of the model. This effect is almost entirely due to the inclusion of the foreign excess market return. The foreign SMB and HML factors are in general not significant and ad little or no value to the model.

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1. Introduction

Brazil is a country which has experienced increased attention from the rest of the world in the recent years. The BOVESPA (Bolsa de Valores de São Paulo) is the largest stock exchange in Latin America and the economy is in a better state than ever. The economy has recently experienced a growth rate of about 4 % and the macroeconomic conditions are generally improving. Almost every multinational company has operations in Brazil. Even Norwegian companies such as Statoil and Hydro are now involved in one of the most exciting emerging markets in the world. The stock market has experienced a recent boom and almost increased its market capitalization tenfold between 2002 and 2007. In the same period the participation of international investors rocketed.

However, Brazil does not have a developed economy; both the macroeconomic conditions and the stock market are more volatile than those of more developed countries. This raises concerns about the predictability of Brazil's stock market for investors. There have been some studies of the development and predictability of the Brazilian stock market, but these are by no means exhaustive.

The Capital Asset Pricing Model (CAPM) is arguably the most important and most frequently tested model within finance. Basically, the CAPM relates the excess return on an asset to the excess return on the market portfolio. An asset has a given level of risk which can be divided into two parts, systematic and unsystematic risk. Systematic risk is the market risk which influences a large number of assets. Unsystematic risk is what can be diminished by diversifying your investments, i.e., it is the risk exclusive to the asset. Thus, if you hold a large number of stocks in your portfolio, the unsystematic risk of the assets will be "netted out." There is no reward in holding unsystematic risk since it can be diversified away, thus priced risk is proportional only to systematic risk. The CAPM introduces the beta term which measures an asset's risk in relation to the market portfolio's risk. An asset, or a portfolio of assets, can be riskier or less risky than the market portfolio, but in the CAPM world it is always efficient since diversifiable risk has been eliminated. I.e., the reward you get is proportional to the risk you are willing to take.

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The objective of this paper is to attempt to establish whether if the three-factor model and an international six-factor model yield good explanatory power for the common variation of stock returns for stocks on the BOVESPA between 1995 and 2006. These models can be used in applications where it is needed to calculate expected returns. This includes cost of capital calculations, portfolio performance benchmarks and risk analysis.

The contribution to the existing literature will be twofold. First, the three-factor model will be extended to an international six-factor model incorporating proxies for world factors from the U.S. market. This is done to check for international influence on the Brazilian equity market.

The U.S. is chosen because of its assumed relatively extensive economic integration with Brazil compared to other developed markets. Second, the approach to forming the SMB and HML factors will be different to that of Fama and French (1992). By grouping the stocks dependently, first according to size and then according to the B/M ratio, we will get portfolios with an equal number of securities (give or take one). This approach is chosen because of the relatively few stocks listed on the BOVESPA. By utilizing Fama and French's methodology, we will at times get very few stocks in some portfolios, thus giving a more uncertain description of the market.

These problems will be addressed by regressing nine excess portfolio returns on the excess market return and the SMB and HML factors using Microsoft Excel's statistical tools. First we run a number of regressions using Brazilian data only. Then, we extend the model to the international six-factor model where the additional U.S. factors will be utilized. The relative applicability of the different models is discussed comparing the R-squared measure and the average of the absolute values of the intercepts. Moreover, the significance of the slope coefficients for excess market return and the SMB and HML factors will be investigated by studying their p-values.

We find that the domestic three-factor model works better than the CAPM explaining variation of stock returns. However, the results found here are less convincing than those of the U.S. market. We also find that the portfolio construction applied here gives a better description of the Brazilian stock market since the negative relationship between size and return and the positive relationship between the B/M ratio and return are confirmed. Moreover, extending the model from the domestic three-factor to the international six-factor model somewhat improves the explanatory power of the model. This effect is almost entirely due to the inclusion of the foreign excess market return. The foreign SMB and HML factors are in general not significant and add little or no value to the model.

The remaining of this paper is organized as follows: Chapter 2 gives an overview of the Brazilian economy and the predominant stock exchange, the BOVESPA. Chapter 3 explains the theory and reviews the existing literature. The data and descriptive statistics are provided in chapter 4 wheras the regression results are given in chapter 5. Finally, chapter 6 concludes.

2. Historical Background

2.1 The Economy

2.1.1 Brazil's economy at a glance

Brazil's economy has experienced growth at around 4 % in recent years and the macro-economic conditions have generally improved.[1] The inflation rate reached one digit in 2003 and in 2006 it was at around 3 %, i.e., below the 4.5 % target. This effect is, of course, due to a tight interest rate policy. For example, in 2003, the interest rate was increased to 26 % per year to address the high inflation rate of the previous year. In recent years it has been in the range of 14 to 16 %. The trade balance has been positive and has beaten records consecutively since 2002. This effect is to some extent attributable to increased prices on some of Brazil's exports, e.g. iron and soybean. In 2006 the Brazilian trade surplus was 44.2 billion USD, i.e. 2.2 % of GDP. Moreover, public debt fell from 57 % to 50 % of GDP from 2003 to 2004, and keeps decreasing.

2.1.2 Recent History

After many years of dictatorship in Brazil a presidential parliamentary democracy with a multiparty system was finally established in 1985. The economy the dictators left was in need of a large-scale fiscal reform. Brazilian authorities launched three different plans to reform the ailing system: the Cruzado plan (86), the Bresser Plan and the Summer Plan (89). These plans were aimed at lowering inflation, which was hovering at very high levels. They achieved some short-term success, mostly by imposing frozen prices. However, due to failed readjustment of wages, excessive demand caused inflationary pressures and again high inflation prevailed. The eighties ended with high and accelerating inflation and an enormous public debt. The Collor government tried another price freeze, but yet again it did not solve any problems. President Collor was by the way impeached on corruption charges in 1992. The

[1] All numbers and facts are taken from Ministério da Fazenda's (The Brazilian Ministry of Finance) homepages, especially Portal do Investidor (The Investor's Portal): http://www.portaldoinvestidor.gov.br/

economy was alternating between growth and recession, and inflation was at a staggering 30 percent per month. In 1994 Fernando Cardoso launched the Plano Real which introduced an equilibrium budget, a process of general indexation and a new currency, the Real, pegged to the dollar. The peg helped curb inflationary expectations. However, inflation went down slowly, thus a real appreciation of the Real was inevitable, leading to a large current account deficit. Nevertheless, the plan was successful at bringing stability to the Brazilian economy. Cardoso was reelected in 1998 and led Brazil through the subsequent financial crisis. However, due to highly unequal wealth distribution President Lula was elected in 2002 vowing to improve the living conditions of Brazil's many poor. Investors were scared by Lula's agenda to address social inequality. The investors' fears were, however, quickly diminished, since Lula and his government kept Cardoso's economic policies. Today the minimum wage has increased and Lula has improved the living conditions of the poorest. Lula was reelected in 2006 even though his government had been accused of corruption on several occasions.

2.1.3 Economic integration

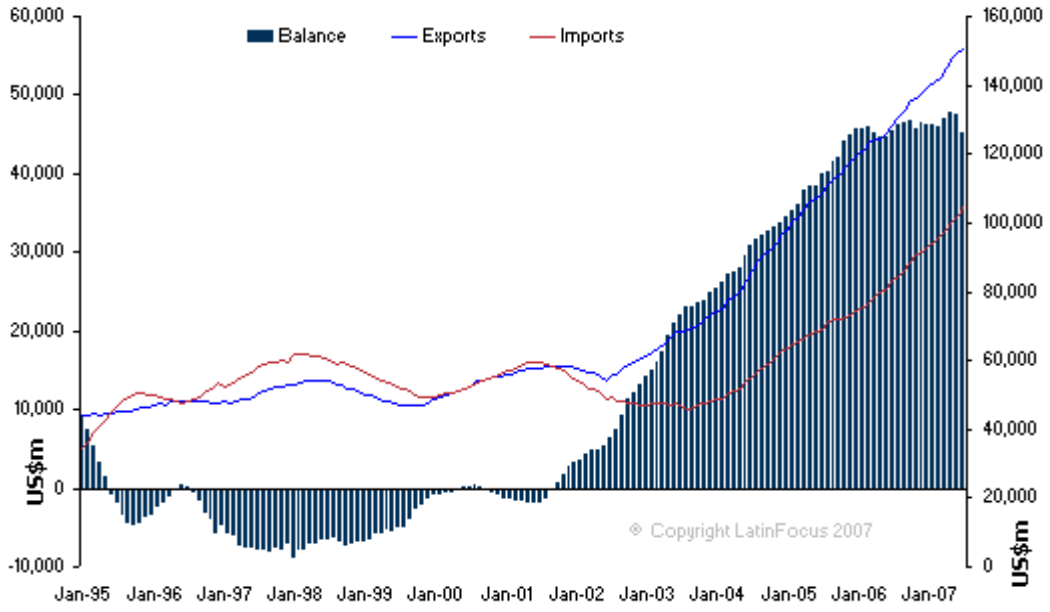
It is interesting to look at some proxies for economic integration all the time one of the contributions of this paper is to investigate foreign influence on the stock market. Overall, the world is becoming increasingly integrated through trade in commodities, services and financial assets. In particular, it has become easy to trade financial assets in a wide range of markets throughout the world. The so-called home bias[2] still exists, but, according to Kerney and Lucey (2004), it is decreasing over time. One way of measuring economic integration is to look at the bilateral trade balance. In 2006 Brazil had a positive trade balance of 44.2 billion USD. Imports grew by 26.86 % whereas exports grew by 10.46 %. The large increase in imports reflects the increased investments in Brazil, especially industrial machines, accessories and parts for the industries. Moreover, foreign direct investment was at 18.8 USD billion in 2006, reaching 34.3 billion USD in July 2007 accumulated over 12 months. Thus these indicators are pointing towards increased market integration with the rest of the world. Figure 1 shows the evolution of imports, exports, foreign exchange and the trade balance in

[2] The home bias refers to the fact that investors invest a disproportionate large share in the domestic market, thus not receiving an optimal portfolio return.

Brazil in the period 1995-2007. A sharp growth trend is seen since 2001, where exports have outperformed imports.

Figure 1

Evolution of Brazilian Trade - $US Million[3]



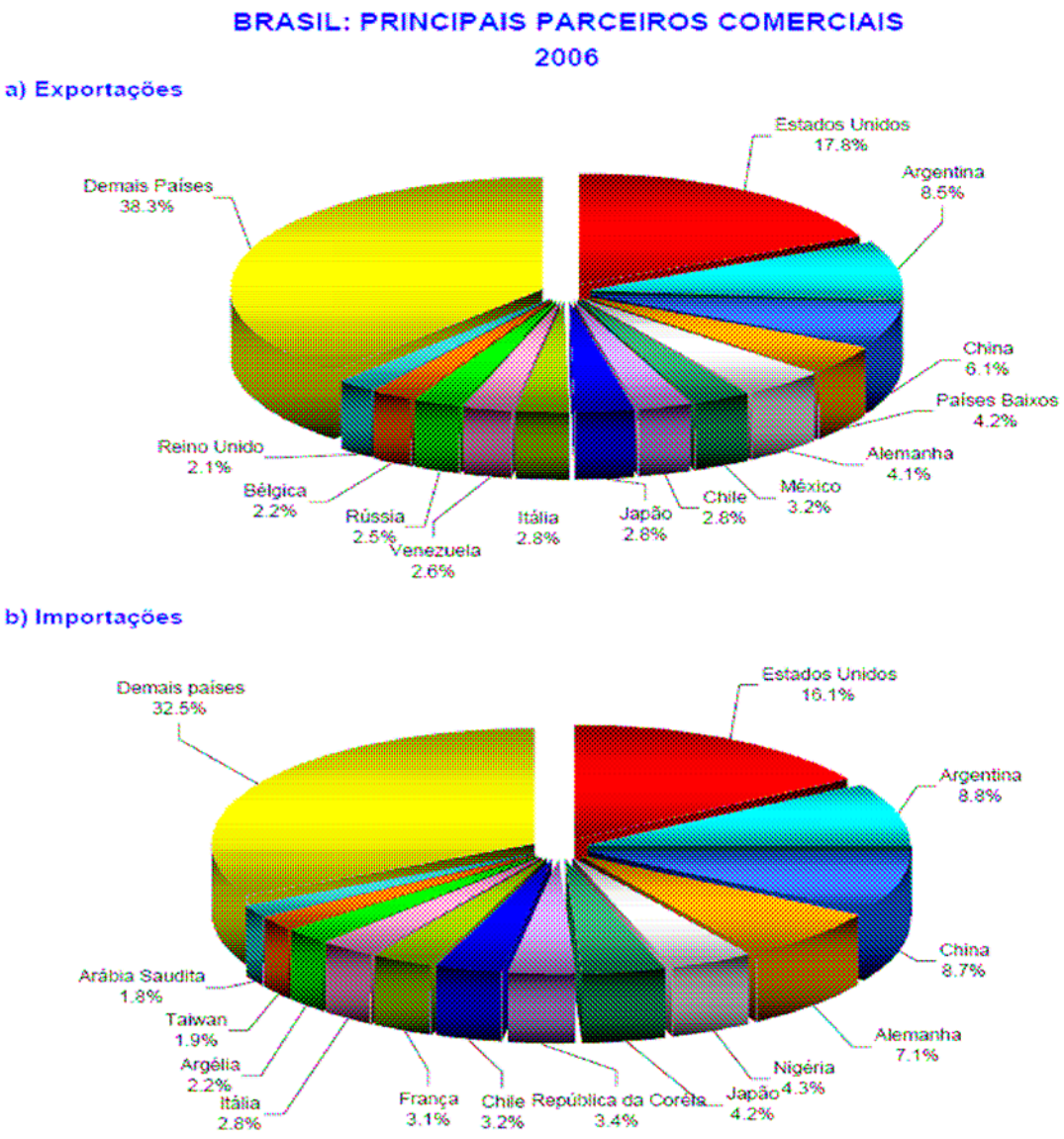
The ties between Brazil and the U.S. are of particular interest since U.S. data are utilized as proxies for world data. In figure 2 the percentage volume of exports and imports are shown. The United States (Estados Unidos) is Brazil's largest unilateral trading partner. The U.S. accounts for 17.8 % of Brazil's exports and 16.1 % of its imports. The net effect is a 7 billion USD deficit for the U.S. Thus, the U.S. accounts for about 16 % of Brazil's trade balance surplus and it is the biggest trading partner of Brazil. The stock market too is increasingly getting interrelated. For example, the turbulence after the U.S. housing crisis discovered in

[3] http://www.latin-focus.com/latinfocus/countries/brazil/bratrade.htm

July caused the BOVESPA to slump about 11 % in two weeks.[4] Moreover, geopolitical conditions may affect the stock market. For example, Argentina's economic distress affected Brazil since investors regarded the whole region as more risky.

Figure 2

Brazilian trading partners[5]



[4] www.bovespa.com.br

[5] www.braziltradenet.gov.br/ARQUIVOS/IndicadoresEconomicos/INDRepublicaTcheca.pdf

2.2 The stock market

2.2.1 BOVESPA at a glance

In June 2007 the market capitalization of the BOVESPA was at 1,023 billion USD and there were 419 listed companies.[6] Average daily trading value stands at about 1,985 billion USD. Moreover, in the first two quarters of 2007 there were 28 Initial Public Offerings (IPOs) compared to 26 IPOs in all four quarters of 2006. In these IPOs, total capital raised was about 9.4 billion USD with international investors accounting for 70 %. The BOVESPA itself went public recently, raising no less than 6.6 billion reais ($3.7bn; £1.8bn).[7] The stock was priced at 23 reais when listed and rocketed to 34.8 reais at closing the next day. This was largely due to an enormous interest from international investors. The evolution of the market capitalisation on the BOVESPA is given in figure 3 below. Between 1995 and 2006, the period investigated in this paper, the market capitalization almost increased tenfold, from 148 to 1023 billion USD in June 2007. However, this increase has been experienced in recent years, i.e., from 2002 onwards. In Figure 4 we see that foreign investor participation increased with about 10 % in the period 2002-2006. In 2006 foreign investors accounted for 35.5 % of total traded value on the BOVESPA, i.e., more than any of the other investor groups. Nevertheless, Brazil's stock market is regarded as more risky than more developed markets. This is for example due to unstable political conditions, where for example crime and the endless corruption scandals that are "always" happening in Brazil may affect the stock market.

[6] All numbers and facts found at: http://www.bovespa.com.br/pdf/FactsFigures.pdf and http://www.bovespa.com.br/pdf/overview.pdf

[7] http://news.bbc.co.uk/2/hi/business/7064810.stm

Figure 3

Market Capitalization at BOVESPA[8]

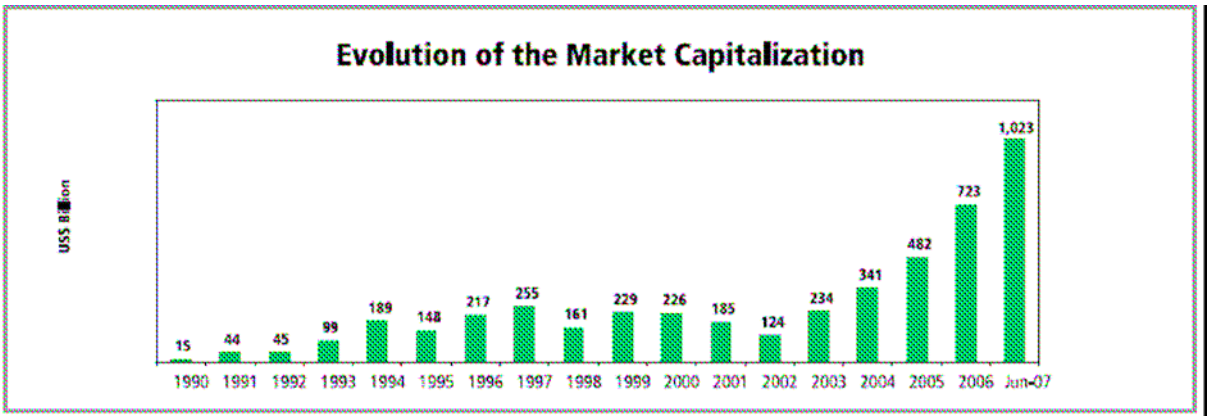
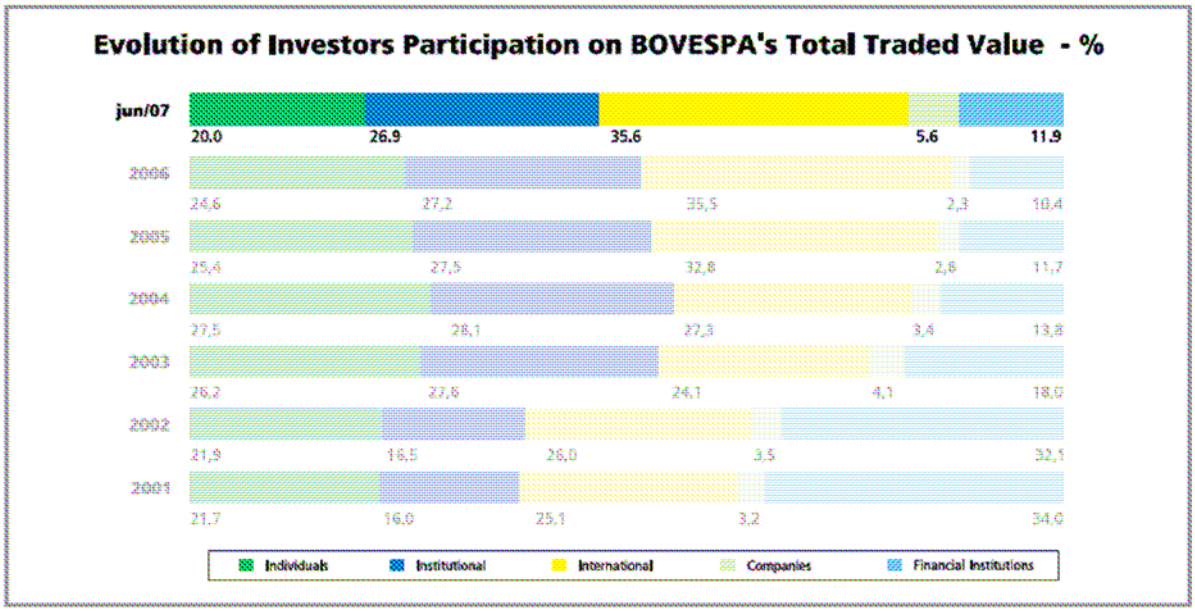


Figure 4

Investor Participation on BOVESPA[9]



[8] http://www.bovespa.com.br/pdf/FactsFigures.pdf

[9] http://www.bovespa.com.br/pdf/FactsFigures.pdf

2.2.2 History

The BOVESPA was founded in 1890 and has grown to become the largest stock exchange in Latin America. However, until the 1960s Brazilians preferred to invest in real assets, e.g., real estate, avoiding bond investments. The stock markets were owned by the states and the brokers were government appointed. In 1965/1966 the stock markets changed to a non-profit autonomous civil association and the brokers became commercial. One year later a law was passed enabling taxpayers to use some of their owed income tax on investments in public-held companies' share funds. These incentives created a boom in the stock market, as there were lots of investors, but few stock issues by the companies. After a peak in 1971 many investors started selling their shares to cash in profits, thus leading to a fall in the stock market. This situation was accompanied by issues of new shares from the companies who finally reacted to the increased interest from investors. This of course made the situation even worse as many investors wanted to sell their shares due to the sudden drop in the market. "The boom of 1971" left the stock market with a bad reputation for years to come and the market was dominated by share issuing companies without commitments to their shareholders. Later incentives such as tax exemption for stock return gains and better legal protection helped somewhat to improve the level of investment, but it was not before the 1990s activity picked up. The volume of international investments increased as the Brazilian economy opened up. Moreover, Brazilian companies started listing their shares on foreign exchanges such as the New York Stock Exchange. These companies were forced to adopt the stricter corporate governance principles of the North American market. The increased market integration led to increased demand for new corporate governance rules since the foreign investors were not happy with the lack of management transparency and monitoring opportunities. Moreover, during the financial crisis in the late 1990s the number of companies listed on the BOVESPA decreased and the market capitalization went down. To combat this, the "Novo Mercado," i.e., the new market, was launched. This is a framework in which companies voluntarily adopt good corporate governance practices. Moreover, the rights of the minority shareholders were improved, leading to greater investor participation. These changes have contributed to the gradual increase of activity on the BOVESPA since 2003. As an example, there were 4 IPOs between 1996 and 2003. As mentioned above, in 2006 there were 26. The increased transparency and monitoring opportunities that has followed the Novo Mercado rules have led to the large increase of foreign investors in the Brazilian market, leading to the 10 % increase seen in figure 4 above.

3. Theory and background

3.1 The CAPM

The CAPM is perhaps the most important model within the field of finance and according to Graham and Harvey (2001) the CAPM is the most popular model for estimation of the cost of equity in US companies. Here the presentation of the model shall be limited to a brief intuitive explanation of its derivation and implications. For a thorough derivation, explanation and a presentation of the assumptions of the CAPM see Danthine and Donaldson (2005)

The CAPM is given by equation (1) below. The *beta* of an asset is given by: $\beta_j = \frac{\sigma_{jM}}{\sigma^2_M}$, i.e., the ratio between the covariance of the market return and the asset return and the variance of the market return.

(1) $$r_j = r_f + \beta_j (r_m - r_f)$$

Where,

r_j is the return on asset *j*

r_f is the return on the risk free asset

r_m is the return on the market portfolio

Rewriting this using the definition of the beta gives the following expressions:

(2) $$r_j = r_f + \frac{(r_m - r_f)}{\sigma_M}\beta_j\sigma_M = r_f + \frac{(r_m - r_f)}{\sigma_M}\rho_{jM}\sigma_j$$

By investigating (2) it is clear that the priced risk is given by the market price of risk multiplied by the portion of total risk that is priced, i.e., $\rho_{jM}\sigma_j < \sigma_j$. It is this priced risk that

is the systematic (market-, or undiversifiable) risk of asset *j*. Thus, it is by this portion that the inclusion of asset *j* increases the variance of the market portfolio. Since the investor now holds a portfolio with a higher risk he must be compensated by a higher expected return on the portfolio. In other words, an assets beta measures as to which extent the assets' risk is related to the market portfolios' risk. For example, a beta equal to one implies that the assets risk is at the same level as the market risk, thus the expected return is the same as for the market portfolio. A beta larger than one implies an asset more risky than the market portfolio and thus a higher expected return and vice versa. The remaining risk of an asset is the unsystematic (diversifiable) risk, i.e., the risk that is unique to the asset. However, in an efficient portfolio, all unsystematic risks have been diversified away. Thus, the expected return on an asset is proportional to its beta. The model given in (1) leads to the following econometric model that will later be used performing the regressions:

$$(3) \qquad R_{P_{it}} - R_{ir_t} = a + b\left[R_{m_t} - R_{ir_t}\right] + e_{i,t}$$

Where,

$R_{P_{it}}$ = the excess return portfolio *i* in month *t*

$R_{m_t} - R_{ir_t}$ = the market premium in month *t*

$e_{i,t}$ = the residual of the model referring to portfolio *i* in month *t*

Given a zero intercept, the beta of an asset is the only determinant explaining the excess return on an asset, or for our purposes, the excess return on a portfolio.

However, a vast number of empirical studies to verify the applicability of the CAPM to price assets have yielded unsatisfactory results. In general, the CAPM does not explain the variation of stock returns very good. This implies that there are risk factors that are not fully accounted for by the beta term incorporated in the CAPM.

3.2 The Fama and French three-factor model

To accommodate the poor performance of the CAPM Fama and French (1992, 1993, 1995, 1996 and 1998) explain over a series of papers how a multifactor model better explains cross-sectional and time-series stock returns. Fama and French (1992) find evidence in the literature (see for example Banz (1991), Reinganum (1981) and Lakonishok (1991)) that, given their beta estimates, the average returns on small (low market equity) stocks are too high, and similarly, that average returns on large stocks are too low. The effect is mostly attributable to the 1980s, but since there exists some evidence that there is a negative relation between firm size and risk, Fama and French (1992) decide to check for its possible explanatory power for stock returns. Moreover, Fama and French (1992) find that average returns on U.S. stocks are positively related to the ratio of a firm's book value of common equity, BE, to its market value, ME. Firms with low earnings have high BE/ME ratios due to their low relative stock price, while low BE/ME implies high earnings. This result is confirmed by for example Stattman (1980) and Rosenberg, Reid and Lanstein (1985). Other factors that have been given a role in explaining stock returns are the earnings/price ratio (E/P) (see Ball 1978) and leverage (see Bhandari 1988).

Based on the findings presented above, Fama and French develop the three-factor model:

$$(4) \qquad R_{P_{it}} - R_{ir_t} = a + b\left[R_{m_t} - R_{ir_t}\right] + s\left[SMB_t\right] + h\left[HML_t\right] + e_{i,t}$$

Where,

$R_{P_{it}}$ = the return of portfolio i in month t less the risk-free rate of return

$R_{m_t} - R_{ir_t}$ = the market premium in month t, i.e., the market portfolio return – the risk free rate

SMB_t = the premium for market size in month t

HML_t = the premium for the book-to-market ratio in month t

$e_{i,t}$ = the residual of the model referring to portfolio i in month t

Following Fama and French (1993) the three factors, beta, market size and the book-to-market ratio should be significant and sufficient in the explanation of the asset returns. Fama and French (1993) use a time-series approach to regress U.S. monthly excess portfolio returns between 1963 and 1991 on the excess monthly market return as well as on mimicking portfolios for size, the book-to-market ratio and term-structure risk factors in returns. This approach has appeal because the risk sensitivity to the factors can be directly measured using R^2 and the slopes. High R^2 and significant factor coefficients imply a well described model. Similarly, the intercepts provide a good metric for the fit of the model, since the asset pricing model should produce intercepts close or equal to zero, see for example (Griffin 2002). They find that the intercepts from their three-factor model are indeed close to zero, the R^2 terms are high and the factor coefficients are in general significant. Other authors, for example Khotari and Shanken (1997) and Dunne (1999) find supporting evidence that the book-to-market factor helps explain common return for stock time-series. Fama and French (1992) find that the combination of size and book-to-market equity seems to absorb the roles of leverage and E/P in average stock returns. Thus, firm size, ME, captures some of the risk of a stock while the BE/ME ratio is a proxy for another part of the risk.

Why, then, do these factors proxy for risk? Fama and French (1993) argue that the size effect is due to the influence of size on profitability. Small firms have lower earnings on assets than large firms. Thus, Fama and French argue that size may be a factor that is associated with an underlying risk factor. Intuitively, a smaller firm is probably less diversified and more sensitive to negative financial events, hence smaller firms are riskier. The book-to-market effect may arise since a firm with a high BE/ME has low earnings on assets while low BE/ME firms have high earnings. Thus, profitability might be the source of a common risk factor that could help explain the positive relationship between BE/ME and return. Indeed, Fama and French (1998) find evidence that "High B/M, E/P (earnings to price), and C/P (cash flow to price) tend to have persistently low earnings. Conversely, low B/M, E/P and C/P stocks tend to be strong (growth) firms with persistently high earnings". An intuitive explanation may be that a firm has moved to the high B/M portfolio because its market value has decreased due to grim future prospects or some other difficulty. Thus, it is plausible that the firm is exposed to for example a higher risk of financial troubles. Nevertheless, size and the B/M ratio lack a good explanation of why they proxy for risk. There are still no good answers as to which underlying risk factors these two factors might represent.

3.3 Critique

Critique to Fama and French's approach to interpreting the factors exists. The size and book-to-market effects do not compensate for risk bearing, they may rather have an effect due to investor overreaction as argued in Lakonishok et. al. (1994). I.e., investors have a tendency to overreact to corporate news, thus, for example, incorporating high growth prospects for an unrealistically long future period. Hence, growth stocks (low BE/ME) are overpriced, whereas value stocks (high BE/ME) are underpriced. Knez and Ready (1997) find that there is a positive relationship between size and return when the extreme observations are excluded each month, i.e., the complete opposite of Fama and French's findings. The interpretation is that the negative size effect found by Fama and French is driven by a few positive surprises each month. Trescartin, Jr. (2000) find that B/M ratio, size, cash flow and sales growth all are factors that perform poorly explaining variation in stock returns. Fama and French (2000) themselves find that the size effect has diminished in the U.S. market towards the new millennium.

In any case, the relatively good explanatory power of the three-factor model may be because the SMB and HML factors do a good job describing a wider set of risk factors that "just happens" to be well described by market size and the B/M ratio. Thus, although the Fama and French model explains better the variation in stock returns compared with the traditional CAPM, the ad hoc specification of the set of priced factors weakens its appeal since the authors ignore theoretical restrictions in a structural model. To address this, some models incorporating higher co-moments have been constructed, see for example Dittmar (2002) or da Silva (2004). These models have a foundation in preference theory, but have not been very successful at explaining the variation of stock returns.

3.4 International studies

Fama and French (1998) find international evidence that value stocks have higher returns than growth stocks. Indeed they outperform growth stocks in 12 out of 13 markets. These are, however, developed markets. For our purposes it is interesting to look at some studies

regarding developing markets. Harvey (1995) finds that average returns are higher in emerging markets than in developed markets for the period 1987-1995. Fama and French (1998) report that only 2 of 16 emerging markets have lower average returns than the developed markets. However, these markets are far more volatile. The market portfolio of the 16 countries has a standard deviation above 50 %. Nevertheless, Fama and French (1998) confirm their results from the developed markets that value stocks outperform growth stocks also in emerging markets. This is also true regarding the size effect. Fama and French find that the average returns on small stocks tend to be higher than the returns on big stocks.

Barry et al. (2001) investigate 35 emerging equity markets in the period 1985-2000, among these Brazil. The countries' data are pooled and world emerging market factors are constructed. Thus, an investigation of Brazil's equity market on its own is not conducted. They find that the book-to-market effects are significant and robust to non-normality tests and size effects. Moreover, they do not depend on extreme returns. The size effects, on the other hand, are found because of extreme returns. Thus, although size effects are present, they are not robust like the B/M effect.

Fama and French (1998) show that a world two-factor model works better than the world CAPM in explaining variation of stock returns. Griffin (2002) criticizes Fama and French's approach since they do not compare their world factor model to country-specific models. Griffin argues that it is important to check whether the stock returns are best explained using global or country specific Fama and French factors. For example, Griffin states that the average difference for expected return estimates between the domestic and the global three-factor model is 8, 41 % per year for U.S. stocks. Hence, if the correct model is not chosen, errors in capital budgeting, portfolio- and risk analysis may occur. The world model assumes that there is one set of factors that describe expected returns in all countries. This builds, of course, on the assumption of an efficient and integrated capital market. Griffin finds that the domestic factor models explain much more time-series variation in returns and generally have lower pricing errors than a world model. Griffin also extends the three-factor model to an international context by adding foreign factors to the domestic three-factor model. This international six-factor model is given by:

$$(5) \qquad R_{P_{it}} - R_{ir_t} = a + bd\left[(R_{m_t} - R_{ir_t})\right] + sd\left[SMB_t\right] + hd\left[HML_t\right]$$
$$+ bf\left[(R_{m_t} - R_{ir_t})\right] + sf\left[SMB_t\right] + bf\left[HML_t\right] + e_{i,t}$$

The terms *d* and *f* determine domestic and foreign factors, respectively.

The international model is unweighted with respect to market capitalization. Griffin finds that the inclusion of international factors leads to a statistically significant, but economically small increase in explanatory power. However, Brazil's stock market has never been investigated with an international model. Since there are a large share of international investors and increasing international economic activity in general, it is interesting to see if the international six-factor model may lead to increased explanatory power for variation of stock returns compared to the domestic three-factor model.

3.5 Empirical studies from Brazil

Horng (1997) tested the CAPM in the Brazilian market using stocks from BOVESPA to see if higher risk was associated with higher return. He concludes that it is not possible to accept the hypothesis that returns are positively related to risk measured with the market beta. Bruni (1998) investigated the influence of beta, firm size, debt level, the price-to-profit ratio, the price-to-sales ratio and the B/M ratio on the return of assets using the returns from BOVESPA between 1988 and 1997. He finds that three factors are significant and related to the asset returns: the B/M ratio, the debt level and the price-to-sales ratio. Mellone Jr. (1999) also tested if the beta could explain the returns of the stocks on the BOVESPA using returns between 1994 and 1998. He finds a positive linear relation between the beta and return, but it was not significant. Costa Jr. and Neves (2000) checked for the influence of the market value of a company, the price to profit ratio and the book-to-market ratio on stock returns. They conclude that the most relevant variables are the market value and the book-to-market ratio. The price to profit ratio was also statistically significant, but presented less explanatory power. However, the beta term was more significant in the Brazilian market than the beta term found in the study of Fama and French (1992). Malaga and Securato (2004) find that the

three-factor model explains the returns in the Brazilian asset market between 1995 and 2003 better than the traditional CAPM. Lucena and Pinto (2005) find that the ARCH and GARCH models improve the original model of Fama and French in the Brazilian market. This is achieved by accommodating the presence of heteroskedasticity. Finally, da Silva (2004) incorporates higher co-moments as well as the Fama and French parameters to see if this can explain better the returns in the Brazilian market between 1990 and 2003. He finds that the Fama and French factors are important for explaining asset returns whereas the higher co-moments ad some, but not much value.

3.6 Econometric method and implications for Brazil

Several empirical versions of the above defined models will be investigated utilizing the Ordinary Least Squares (OLS) technique to estimate the slopes in the different regressions. When making statistical inference it is important to remember that small changes in data grouping, variable definitions, and sample time length might alter the regression results dramatically. Moreover, OLS builds on a list of crucial assumptions which may very well not hold. The most important for our purposes are:

1. The variance of the random error e is

$$\text{var}(e_t)=\sigma^2=\text{var}(y_t)$$

2. The covariance between any pair of random errors, e_i and e_y is

$$\text{Cov}(e_i, e_y)=\text{cov}(y_i, y_y)=0$$

3. The residuals are normally distributed

$$e \sim N(0, \sigma^2)$$

Of course, if the assumptions do not hold, the OLS results should be treated with great care when making statistical inferences. For example, when the variances of the observations are not the same, i.e., the first assumption does not hold, we say that heteroskedasticity, as opposed to homoskedasticity, exists. Similarly, If the assumption about uncorrelated error terms does not hold, it is evidence of autocorrelation. I.e., the error term contains a carryover effect from previous shock. Presence of heteroskedasticity and/or autocorrelation implies that the hypothesis tests and confidence intervals reported by OLS may be misleading. The same is true for not normally distributed residuals. For example, Fama and French (1998) point out that returns in emerging markets generally are leptokurtic and right skewed, thus statistical inference may very well be a perilous exercise.

Lucena and Pinto (2005) apply the three-factor model of Fama and French and run a number of tests to check for anomalies in the error terms. They build on the fact that stock time-series returns often experience presence of autocorrelation of the residuals, non-normal residuals and heteroskedasticity. First, however, they apply the Regression Specification Error Test (RESET) on the three-factor model using 25 portfolio returns between 1994 and 2004. They only reject the hypothesis that the model is correctly specified for two portfolios. Thus, the three-factor model should in general provide a good way of explaining variation of returns using Brazilian stocks. Next, Lucena and Pinto check for autocorrelation of the residuals using both the Durbin-Watson (DW) test for one lagged period and the Breusch-Godfrey (BG) test with 12 lagged periods. With the DW test, the hypothesis of absence of autocorrelation is not rejected for 10 portfolios and rejected for 8 portfolios, while the remaining yielded inconclusive results. Thus, it is not easy to determine whether autocorrelation is an important feature of the residuals. The BG test yielded more conclusive results since the hypothesis of absence of autocorrelation was rejected only for three portfolios. The Jarque-Bera (JB) test for non-normality of the residuals yields convincing results since the hypothesis of normally distributed residuals was rejected for all the portfolios. Similarly, the White test for heteroskedasticity found a large presence of this feature. The hypothesis of heteroskedasticity was rejected only for one portfolio.

To model these volatilities they utilize an autoregressive conditional hetereoskedasticity (ARCH) model that consider the variances of the error terms to be functions of the previous periods' error terms. They find that the coefficients are in general significant. However, the ARCH model only measures the volatility of the error terms, and does not improve the model in itself. It is a risk measure that can be used when undertaking economic decisions, but does not change any coefficients in the original model. Nevertheless, Lucena and Pinto show that other endogenous variables could yield more statistically significant results than the Fama and French factors. The problem is that no one has found any factors that work better. Thus, the three-factor model will be applied here regardless of the presence of the residual anomalies found by Lucena and Pinto. It is important to remember these features of the error terms when making statistical inference, but for the moment we take comfort in the fact that the RESET test for model specification confirmed the proposition that the three-factor model should work well explaining variation in returns in the Brazilian market.

4. Data description and estimation

4.1 Preliminaries

When moving from the theoretical CAPM model to an econometric model some problems are encountered. First, a risk free rate is needed, but a 100 % risk free rate unfortunately only exists in theory. A normal procedure is to utilize government bonds as a proxy for the risk free rate. This is a fairly safe option since the government controls the money supply. However, this is not entirely risk-free. For example, inflation may affect the rate of return on the bonds. In Brazil it has been common procedure to use the Interbank Certificate of Deposit (CDI) yield, hence the CDI is used as the risk free rate in this paper too.

The market portfolio yields problems as well. This is supposed to be a portfolio incorporating all investments possible. I.e., it should account for investments such as stocks and bonds, for which quotes are normally readily available. However, the market portfolio also consists of other investments, e.g. in real estate and human capital, for which returns are not always easily found. Thus, due to lack of conclusive data, it is not possible to construct a market portfolio that reflects all possible investments. This implies that a proxy for the market portfolio is needed. In Brazil common practice has been to utilize the BOVESPA index as a proxy for the market portfolio. The BOVESPA is a value weighted index that reflects the most traded stocks and is hence an average indicator of the market performance. On average, it represents 80 % of market liquidity and 70 % of market capitalization.[10]

Moreover, the data collected is given in real numbers, i.e., they are adjusted for inflation. This seems to be standard procedure in Brazil in contrast to the procedures used elsewhere. All quotes should ideally have been in nominal terms, but given the dataset in real numbers, it was necessary to make an approximation regarding the risk free rate, as this was not inflation adjusted. The adjustment was done by subtracting the inflation rate from the CDI yield each month to find the real interest rate. This is not an optimal approach, but it allows for somewhat easier comparison with the other Brazilian studies. All the closing prices were

[10] These numbers are found at www.bovespa.com.br

deflated using IPCA.[11] Unfortunately, the using real numbers we run into one more problem. The U.S. excess market return and SMB and HML factors are all calculated with nominal terms. Thus, more noise is added to the regressions.

The time-series regressions are performed with data from 1995-2006. This time-period is chosen because of the very unstable economic conditions both in the Brazilian economy and in the stock market in the prior period.

4.2 The data

Theoretically each security's return could be investigated. However, as this leads to cumbersome estimation procedures, portfolios were constructed to limit the number of parameters. Equally-weighted portfolios are constructed to analyze the return of a group of securities rather than individual stock returns. The Brazilian data is downloaded from the Economatica[12] database whereas the U.S. factors are found at the homepage of Kenneth French. All quotes are from the BOVESPA stock exchange. The market return is given by the BOVESPA index. All the returns are calculated using the formula:

$$R_t = \frac{p_t - p_{t-1}}{p_{t-1}} \tag{6}$$

Where p_t shows the inflation adjusted prices of the asset at time *t*. The monthly returns are calculated between 1995 and 2005, a 144 month period.

[11] IPCA, calculated by the Instituto Brasileiro de Geografia e Estatistica (IBGE), is a comprehensive statistic measuring price changes to families with monetary income from any source ranging between 1 and 40 minimum wages, and includes nine metropolitan areas of the country, besides the municipality of Goiania and Brasilia

[12] Economatica is an Equity analysis tool. It is focused on Latin America and includes 300 listed companies from Brazil

To construct the SMB and HML factors the stocks are first divided in two groups according to market value, small and big, using yearly data from December of year *t*. These groups are equally large. Second, they are divided in three groups according to book value divided by market value using data from the latest fiscal year, i.e., *t-1*. This is done to ensure that the book values are known before the returns they are used to explain. These portfolios are formed at the 30^{th} and the 70^{th} percentile. The portfolios are constructed at the end of December every year *t* utilizing the stock returns for year *t*. This approach differs somewhat to the approach of Fama and French (1992) where the market value from June of year *t* is used to form the size portfolios while market value and book value from December of *t-1* are utilized to divide into the three book-to-market ratio portfolios. However, due to lack of data for market value in any month except December in any given year, we follow the approach of Da Silva (2004), forming the portfolios with book-to-market data from December of year *t-1* and market size data from December year *t.* Following da Silva (2004) each stock must have an observed market capitalization, book value and monthly return data to enter the data set in any year. Stocks with a negative book- to market value ratio are also excluded. After the returns are found the equally weighted 12-month portfolio returns are calculated. This process is repeated every year. Lastly the monthly portfolio returns are calculated for the entire 144-month period 1995-2006. The 6 portfolios are constructed in the following way:

1. Small - Low
2. Small - Medium
3. Small - High
4. Big - Low
5. Big - Medium
6. Big - High

Small and Big refers to the size of the company measured by their stock price times outstanding share. Low, Medium and High refers to the value of the companies' book-to-market ratio. This selection is somewhat arbitrary and follows Fama and French (1992) where they find that book-to-market equity plays a more important role in explaining average stock returns than size. The selection further differs from the Fama and French approach since the

stocks are not sorted on size and book-to-market equity independently. Here, the stocks are sorted according to size, then according to book-to-market value, thus resulting in equally large portfolios. This differs from the Fama and French approach where the stocks are sorted simultaneously on size and book-to-market and then the portfolios are constructed at the intersection between the sorts. This approach is scrapped since it produces unsatisfactory numbers of stock returns to explain in the SL (small size – low B/M) and BH (Big size – high B/M) portfolios. In fact, with independent sorts, some years there are no stocks in these portfolios at all.

The monthly SMB (Small minus Big) and HML (High minus Low) factors are constructed in the following way:

$$SMB = 1/3(\text{Small Value} + \text{Small Medium} + \text{Small Growth}) - 1/3(\text{Big Value} + \text{Big Medium} + \text{Big Growth})$$

$$HML = 1/2\,(\text{Small Value} + \text{Big Value}) - 1/2(\text{Small Growth} + \text{Big Growth})$$

Value and Growth refer to a high and low B/M ratio, respectively. The SMB factor is the average return on the three small portfolios minus the average return on the three big portfolios while the HML factor is the average return on the two value portfolios minus the average return on the two growth portfolios. The two HML components have the same size weights, Small and Big. This enables the HML factor to focus more closely on the behavior of low and high BE/ME firms.

The stock returns are grouped in 9 equally weighted portfolios formed on size and book-to-market ratio. This procedure is chosen since the SMB and HML factors presented above can capture factors in stock returns related to size and book-to-market equity.

The formation of the portfolios is very similar to the formation utilized forming the SMB and HML portfolios. First, the stocks are divided in three groups according to market value:

Small, Intermediate and Big, using yearly data from December of year *t*. These groups are equally large. Second, they are divided in three equally large groups sorted on book value divided by market value using data from the latest fiscal year, i.e., from December of *t-1*. The portfolios are constructed at the end of December every year *t-1*, then the equally weighted monthly stock returns for year *t* are calculated for each portfolio. The portfolios excess returns are used as dependent variables in the time-series regressions. These are the portfolios:

1. SL - Small market value and low B/M ratio
2. SM - Small market value and medium B/M ratio
3. SH - Small market value and high B/M ratio
4. IL - Intermediate market value and low B/M ratio
5. IM - Intermediate market value and medium B/M ratio
6. IH - Intermediate market value and high B/M ratio
7. BL - Big market value and low B/M ratio
8. BM - Big market value and medium B/M ratio
9. BH - Big market value and high B/M ratio

4.3 Descriptive statistics

4.3.1 The portfolios

In table 1 below it comes clear that the firms categorized as small have less than 1% of total market capitalization. On the other hand, the big firms represent more than 94 % of total market capitalization. The largest share is found in the BL portfolio. These big successful firms account for more than 50 % of total market value. This is, not unexpected, similar to the findings of Malaga and Securato (2004) who, for example, finds that the BL firms account for 57 % of total market value.

Table 1

Descriptive statistics for 9 stock portfolios sorted on size and book-to-market equity: 1995-2006. 12 years*

Book-to Market

Average of annual averages of firm size - MV

Size	L	M	H
S	140,48	125,87	68,40
I	972,82	854,03	702,01
B	25.542,72	13.148,83	8.862,07

Average of annual BV/MV ratios for portfolios

Size	L	M	H
S	1,23	2,70	8,69
I	0,70	1,27	2,50
B	0,37	0,79	1,75

Average MV in relation to total market value

Size	L	M	H	Total
S	0,3%	0,2%	0,1%	0,7%
I	1,9%	1,7%	1,4%	5,0%
B	50,7%	26,1%	17,6%	94,3%
Total	52,9%	28,0%	19,1%	

* The 9 size and book-to-market portfolios are formed as follows. All data are collected from the ECONOMATICA using quotations from the BOVESPA. For each year *t* between 1995 and 2006 the stocks are divided into 3 equally large groups sorted by size, i.e. market equity (stock price times shares) using data from December. Similarly, data for book value is collected from ECONOMATICA to calculate the book-to-market ratio. The book-to-market ratio is calculated using data from December of year *t-1*. The three size sorted groups are then sorted on book-to-market equity and the 9 equally weighted portfolios are constructed. The firm size average numbers are given in millions of Brazilian Real.

It can also be noted that the proportion of total market value decreases from lower to higher book-to-market ratio for all the portfolios. This is also found in Fama and French's (1993) paper. They explain it by the fact, that using their independent sorts on size and book-to-market equity the highest B/M ratios will be tilted towards the smallest firms[13].

Interestingly, this effect is not found in the Brazilian study by Malaga and Securato (2004), where the opposite pattern in found in all but the large portfolios. However, since Malaga and Securato form their portfolios sorting for size and book-to-market independently, they get on average five firms in the SL (small size, low book-to-market) portfolio. Hence, the total market value of these firms would not be expected to be very high. It can also be noted here that Malaga and Securato (2004) find that in Brazil, a larger number of firms are in the big size –growth portfolio (BL) than in the small size growth (SL) portfolio. This effect is exactly the opposite of Fama and French's (1993) findings that most growth firms in the U.S. are firms in the bottom size quintile. Obviously, this cannot be commented on in this paper all the

[13] Another point, less important for our purposes, is that they use NYSE (New York Stock Exchange) size and book-to-market breakpoints to form portfolios with stocks from NYSE and NASDAQ and AMEX. Thus, due to the tendency of NASDAQ and AMEX stocks to have lower book-to-market ratios, these breakpoints mean that the NYSE stocks are so-called "fallen angels," i.e., big firms with low stock prices.

time the procedure to construct the portfolios result in portfolios with an equal number of companies.

Thus, although the results presented here are similar to those of Fama and French, the reasoning explaining the results cannot be the same. There is reason to believe that the results simply state that the growth firms are more valuable than the value (high book-to-market ratio) firms in the Brazilian market since this pattern holds for all three size groups. The reason the results are inconclusive with the results from Malaga and Securato's paper must be the different approach forming the portfolios. Malaga and Securato find no clear pattern between book-to-market and the average portion of the market size. However, due to relatively few firms in the SL and BH portfolios and relatively many firms in the SH and BL portfolios in their study, this result is hardly a surprise.

4.3.2. The dependent variables

As can be seen in table 2, the monthly average excess return was between -0.88 % and 1.78 % for the 1995-2006 period. A clear pattern can be seen, the returns decrease going from small size to big size, and the returns increase going from low B/M ratio to high B/M ratio. Hence, our results confirm the proposition made by Fama and French (1993) that there exists a negative relation between firm size and return. This holds for all the three sorts on the book-to-market ratio. The hypothesis that smaller firms are riskier and hence have higher returns is supported. This differs from Malaga and Securato's analysis of the Brazilian stock market. They find no clear relation between firm size and return.

Table 2

Monthly premium and standard deviation for 9 stock portfolios sorted on size and book-to-market equity: 1995-2006. 12 years*

	Monthly Premium					Standard Deviation		
	Book/Market					Book/Market		
Size	L	M	H	Size	L	M	H	
S	-0,52%	0,38%	1,78%	S	9,10%	8,94%	15,39%	
I	-0,73%	-0,35%	0,86%	I	7,54%	7,19%	7,83%	
B	-0,88%	-0,72%	0,17%	B	7,53%	8,24%	9,52%	

* The 9 size and book-to-market portfolios are formed as follows. All data are collected from the ECONOMATICA using quotations from the BOVESPA. For each year *t* between 1995 and 2006, the stocks are divided into 3 equally large groups sorted by size, i.e.

market equity (stock price times shares) using data from December. Similarly, data for book value is collected from ECONOMATICA to calculate the book-to-market ratio. The book-to-market ratio is calculated using data from December of year *t-1*. The three size sorted groups are then sorted on book-to-market equity and the 9 equally weighted portfolios are constructed. The equally weighted portfolio returns are calculated from January through December of year *t*.

The other proposition by Fama and French (1993), namely that a higher book-to-market ratio implies a higher return, is also supported. For each of the 3 levels of size, return increases with the book-to-market ratio. Once more this is not supported by Malaga and Securato who do not find a clear pattern here either. The different results found here and in Malaga and Securato's paper are probably encountered because of the different approaches to sorting the data. This paper also incorporates returns between 2004 and 2006 and thus gives a longer period to be investigated.

The standard deviation varies between 7.19 % and 15.39 %. Fama and French (1993) find that the standard deviations are between 4.27 % and 7.76 %, thus the proposition that Brazil's equity market is riskier than the American is supported. Caution, however, must be taken in reaching this conclusion since Fama and French examine a different time period, i.e., 1963-1991.

4.3.3 The explanatory variables

Table 3 gives the means, standard deviations and the correlations between the explanatory variables in the forthcoming regressions.

The average market return in Brazil between 1995-2006 was at -0.3 %, whereas the corresponding U.S. figure was 0.7 %, thus the Brazilian average return was on average about 1 % lower than that of the U.S.. However, the standard deviation was more than double to that of the U.S., 9.8 % versus 4.3 % in the U.S. market. The notion that emerging markets, Brazil being one, are more risky is thus supported by these data. It can be mentioned, that Fama and French (1998) find the yearly average market return in Brazil to be 34.99 % with a standard deviation of 79.15 % for the 1987-1995 period. These highly volatile equity returns are the reason that most of the literature studying Brazil's stock market is focusing on the period post 1994. Moreover, there are positive premiums both to the SMB and HML factors in both

countries. In Brazil the HML return was almost at 2 %, whereas the SMB return was as low as 0,4 %. As with the excess market return, the U.S. figures are lower, 0.3 % for both the SMB and the HML factors. The U.S. standard deviations are lower too, 3.6 % and 4.3 %, compared to 5.3 % and 6.4 %, for the SMB and HML factors, respectively.

Table 3

Monthly premium, standard deviation and correlation matrix for the explanatory returns used in the regressions in the tables 4 -9: 1995-2006 144 observations*

	Mean	Standard Deviation	*Correlation*	*Rm-Rf*	*SMB*	*HML*	*Rm- Rf*	*SMB*	*HML*
Rm-Rf B	-0,3%	9,8%	Rm-Rf	1					
SMB B	0,4%	5,3%	SMB	-0,32	1				
HML B	2,0%	6,4%	HML	0,15	0,40	1			
Rm-Rf US	0,7%	4,3%	Rm- Rf	0,00	-0,09	-0,02	1		
SMB US	0,3%	3,6%	SMB	0,09	-0,09	-0,16	0,24	1	
HML US	0,3%	4,3%	HML	-0,13	0,02	0,00	-0,30	-0,38	1

*All Brazil data are collected from the ECONOMATICA using quotations from the BOVESPA. Rm-Rf, B, the excess return on the market in Brazil, is the value-weighted return on all BOVESPA stocks minus the Interbank Certificate of Deposit rate. The Brazilian Fama/French factors are constructed using the 6 equal weight portfolios formed on size and book-to-market (not independently). SMB (Small Minus Big) is the average return on the three small portfolios minus the average return on the three big portfolios. HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios, The book-to-market ratio is calculated using data from December in year *t-1*. Market size uses data from December year *t*. The equally weighted portfolio returns are calculated from January through December in year *t*. Stocks with negative book value, not consecutive quotations and no market value are excluded for any given year.

The U.S. Fama/French factors are constructed using the 6 value-weight portfolios formed on size and book-to-market. SMB (Small Minus Big) is the average return on the three small portfolios minus the average return on the three big portfolios. HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios, Rm-Rf, US, the excess return on the market in the U.S, is the value-weight return on all NYSE, AMEX, and NASDAQ stocks (from CRSP) minus the one-month Treasury bill rate (from Ibbotson Associates). Rm-Rf includes all NYSE, AMEX, and NASDAQ firms. SMB and HML for July of year t to June of t+1 include all NYSE, AMEX, and NASDAQ stocks for which we have market equity data for December of t-1 and June of t, and (positive) book equity data for t-1.

It is clear from table 3 that the correlations between the Brazilian SMB and HML factors and their respective U.S. counterparts are low. Following Griffin (2002) this can be viewed as somewhat surprising if you expect the SMB and HML factors to represent the same underlying state variables in integrated markets. Nevertheless, because of their low correlations both the U.S. and Brazilian SMB and HML factors can be included without collinearity concerns

5. Regression results

All regressions are time-series and they are calculated using Microsoft Excel's statistical tools. For these time-series regressions the R^2 terms and the coefficient slopes are evidence of the explanatory power of the model in explaining common variation in the returns. Overall, an asset pricing model does not provide any predictions regarding the size of the R^2 terms. Nevertheless, different asset pricing models can be compared using this measure since well specified models should have higher R^2 terms than poorly specified models. Further, we follow Griffin (2002) and use a measure of the average of the intercepts' absolute values to check for model specification. A lower average intercept implies a better specified model. First, several regressions are calculated using Brazilian data only. Second, international data is introduced to see if the inclusion of these may improve the explanation of variation in stock returns.

5.1 Brazil

First we investigate regressions with excess market return as the explanatory variable, then regressions that use the SMB and HML factors to explain variation in returns. Third, the three-factor model is investigated before we regress the portfolio returns on two-factor models that are combinations of the excess market return and the SMB and HML factors.

5.1.1 The Market

In table 4 the results from the regression of the excess stock returns on the excess market return are given. The R^2 terms are not particularly high, they range between 0.15 and 0.72. Thus, only in some portfolios is excess market return able to explain most of the variation of the stock returns. The three big-size portfolios have the highest R^2 terms, a result that is found in the paper of Fama and French (1993) too. However, the explanatory power of the excess market return in the Brazilian market is a far cry from the results found by

Fama and French (1993), they find that the excess market return explains between 0.65 and 0.92, measured by R^2. Malaga and Securato get R^2 terms ranging between 0.06 and 0.94, thus their approach results in even more inconclusive results. Overall, since the R^2 term is as

low as 0.15 in the SH portfolio, it is clear that there can be gains to extending the model in an attempt to increase its explanatory power. We expect that the SMB and HML factors will have relatively more success at improving explanatory power in the small and intermediate sized portfolios.

Table 4

Regressions of excess stock returns on the excess market return (BOVESPA – Index) between 1995-2006. 144 months*

$$R_{P_{it}} - R_{ir_t} = a + b\left[R_{m_t} - R_{ir_t}\right] + e_t$$

	b			p(b)			
	Book/Market				Book/Market		
Size	L	M	H	Size	L	M	H
S	0,49	0,45	0,62	S	0,00	0,00	0,00
I	0,47	0,46	0,50	I	0,00	0,00	0,00
B	0,60	0,71	0,80	B	0,00	0,00	0,00

	a			p(a)			
	Book/Market				Book/Market		
Size	L	M	H	Size	L	M	H
S	0,00	0,01	0,02	S	0,56	0,43	0,10
I	-0,01	0,00	0,01	I	0,24	0,65	0,05
B	-0,01	-0,01	0,00	B	0,07	0,17	0,39

	R Square			Average Absolutt Value (a)	
	Book/Market				
Size	L	M	H	Avg. Alfa	0,007
S	0,28	0,24	0,15		
I	0,37	0,39	0,39		
B	0,61	0,72	0,66		

* RM is the market return measured by the BOVESPA market index. RF is the risk free rate measured by the the Interbank Certificate of Deposit (CDI) yield. The 9 size and book-to-market portfolios are formed as follows. All data are collected from the ECONOMATICA using quotations from the BOVESPA. Each year *t* between 1995 and 2006 the stocks are divided into 3 equally large groups sorted by size, i.e. market equity (stock price times shares) using data from December. Similarly, data for book value is collected from ECONOMATICA to calculate the book-to-market ratio. The book-to-market ratio is calculated using data from December in year *t-1*. The three size sorted groups are then sorted on book-to-market equity and the 9 equally weighted portfolios are constructed. The equally weighted portfolio returns are calculated from January through December in year *t*.

All the portfolio betas proved statistically significant, in fact the p-values are zero in all portfolios. The intercepts all have low t-values, which lead to the conclusion that they are not statistically different from zero. Their predicted intercepts are close to zero in any case. Moreover, the average of the absolute values of the intercepts is only 0.007, thus supporting the CAPM model which predicts an intercept equal to zero.

5.1.2 The SMB and HML factors

As can be seen in table 5 the SMB and HML factors capture some time-series variation for the excess portfolios returns. The R^2 values are between 0.0 and 0.6, i.e. they are very different across the portfolios. This is similar to the findings of Fama and French (1993) where the R^2 values range between 0.04 and 0.65. However, their findings suggest a pattern between the R^2 values, firm size and the B/M ratio. Small size and low B/M implies a high R^2 value and vice versa. In table 5 no such pattern can be found. Nevertheless, the SMB and HML factors clearly capture some variation in stock returns, but leave a lot to be explained by the market return. Thus, we turn to the three-factor model to investigate the impact of all three factors on the common variation of stock returns.

Table 5

Regressions of excess portfolio returns on the SMB and HML factors between 1995-2006. 144 months*

$$R_{P_{it}} - R_{ir_t} = a + s[SMB_t] + h[HML_t] + e_{i,t}$$

s

	Book/Market		
Size	L	M	H
S	0,45	0,63	0,77
I	0,08	0,02	-0,11
B	-0,51	-0,63	-0,96

Pvalue (s)

	Book/Market		
Size	L	M	H
S	0,00	0,00	0,00
I	0,53	0,84	0,40
B	0,00	0,00	0,00

h

	Book/Market		
Size	L	M	H
S	-0,30	0,23	1,52
I	-0,09	0,07	0,41
B	0,06	0,30	0,69

p(h)

	Book/Market		
Size	L	M	H
S	0,02	0,04	0,00
I	0,40	0,53	0,00
B	0,58	0,01	0,00

a

	Book/Market		
Size	L	M	H
S	0,00	0,00	-0,02
I	-0,01	0,00	0,00
B	-0,01	-0,01	-0,01

p(a)

	Book/Market		
Size	L	M	H
S	0,89	0,64	0,08
I	0,39	0,44	0,88
B	0,20	0,12	0,24

R square

	Book/Market		
Size	L	M	H
S	0,07	0,22	0,60

Average Absolutt Value (a)

Avg. Alfa	0,006

I	0,01	0,00	0,10
B	0,12	0,14	0,30

* RF is the risk free rate measured by the Interbank Certificate of Deposit (CDI) yield. The 9 size and book-to-market portfolios are formed as follows. All data are collected from the ECONOMATICA using quotations from the BOVESPA. Each year *t* between 1995 and 2006 the stocks are divided into 3 equally large groups sorted by size, i.e. market equity (stock price times shares) using data from December. Similarly, data for book value is collected from ECONOMATICA to calculate the book-to-market ratio. The book-to-market ratio is calculated using data from December in year *t-1*. The three size sorted groups are then sorted on book-to-market equity and the 9 equally weighted portfolios are constructed. The equally weighted portfolio returns are calculated from January through December in year *t*. The HML and SMB factors are constructed using the 6 equal weight portfolios formed on size and book-to-market (not independently). SMB (Small Minus Big) is the average return on the three small portfolios minus the average return on the three big portfolios. HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios, Stocks with negative book value, not consecutive quotations and no market value are excluded for any given year.

5.1.3 The three-factor model

As can be seen in table 6, the inclusion of the SMB and HML terms increases the explanatory power of the model compared to the traditional CAPM. The R^2 terms increase substantially for all the portfolios, especially in the SH portfolio, where R^2 increases from 0.15 to 0.78. In general, the R^2 values increase more in the small portfolios than in the large portfolios, this is not surprising remembering the larger improvement potential in the small portfolios. Comparing with Malaga and Securato's paper, the R^2 terms are higher for some portfolios, lower for others. Their R^2 terms ranges between 0.37 and 0.95 while in this paper they range between 0.47 and 0.78. In any case, the three-factor model does not come close to explaining the amount of variation of stock returns that Fama and French (1993) find. Their R^2 values are higher than 0.9 in 21 of 25 portfolios and their lowest R^2 value is as high as 0.83.

Table 6

Regressions of excess stock returns on the excess market return (BOVESPA – Index) and the SMB and HML factors between 1995-2006. 144 months*

$$R_{P_{it}} - R_{ir_t} = a + b\left[R_{m_t} - R_{ir_t}\right] + s\left[SMB_t\right] + h\left[HML_t\right] + e_{i,t}$$

	b				p(b)		
	Book/Market				Book/Market		
Size	L	M	H	Size	L	M	H
S	0,74	0,66	0,75	S	0,00	0,00	0,00
I	0,61	0,57	0,55	I	0,00	0,00	0,00
B	0,63	0,71	0,70	B	0,00	0,00	0,00

		s					p(s)		
		Book/Market					Book/Market		
Size	L	M	H		Size	L	M	H	
S	1,06	1,18	1,39		S	0,00	0,00	0,00	
I	0,59	0,50	0,34		I	0,00	0,00	0,00	
B	0,02	-0,04	-0,38		B	0,85	0,63	0,00	
		H					p(h)		
		Book/Market					Book/Market		
Size	L	M	H		Size	L	M	H	
S	-0,67	-0,10	1,14		S	0,00	0,22	0,00	
I	-0,40	-0,22	0,13		I	0,00	0,01	0,13	
B	-0,26	-0,06	0,34		B	0,00	0,37	0,00	
		A					p(a)		
		Book/Market					Book/Market		
Size	L	M	H		Size	L	M	H	
S	0,01	0,00	-0,01		S	0,25	0,51	0,21	
I	0,00	0,00	0,01		I	0,98	0,90	0,22	
B	0,00	0,00	0,00		B	0,63	0,34	0,74	
		R square					Average Absolutt Value (a)		
		Book/Market							
Size	L	M	H		Avg a		0,003		
S	0,572	0,638	0,783						
I	0,505	0,488	0,470						
B	0,660	0,721	0,704						

*RM is the market return measured by the BOVESPA market index. RF is the risk free rate measured by the the Interbank Certificate of Deposit (CDI) yield. The 9 size and book-to-market portfolios are formed as follows. All data are collected from the ECONOMATICA using quotations from the BOVESPA. Each year *t* between 1995 and 2006 the stocks are divided into 3 equally large groups sorted by size, i.e. market equity (stock price times shares) using data from December. Similarly, data for book value is collected from ECONOMATICA to calculate the book-to-market ratio. The book-to-market ratio is calculated using data from December in year *t-1*. The three size sorted groups are then sorted on book-to-market equity and the 9 equally weighted portfolios are constructed. The equally weighted portfolio returns are calculated from January through December in year *t*. The HML and SMB factors are constructed using the 6 equal weight portfolios formed on size and book-to-market (not independently). SMB (Small Minus Big) is the average return on the three small portfolios minus the average return on the three big portfolios. HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios, Stocks with negative book value, not consecutive quotations and no market value are excluded for any given year.

Regarding the intercepts, we do not reject the hypothesis that the intercepts are different from zero for any of the portfolios. This helps proving the general significance of the model since the theory predicts an intercept equal to zero, i.e., the variation in the variables should be fully explained by the explanatory variables and the random noise. This result is also found in Malaga and Securato (2004) for all nine portfolios. Moreover, the average of absolute values of the intercepts has decreased from 0.007 to 0.003, thus marginally implying an improved model compared to the CAPM.

The beta terms are significant for all the portfolios. Thus, the conclusion from the CAPM, that excess market return explains a substantial part of common variation in stock returns, is supported.

The SMB factor is statistically significant for all the portfolios bar two. Hence, the SMB factor must account for some of the variation not captured by the market and HML factors. In terms of the signs of the coefficients, we can see that the coefficient decreases in value going from small to big portfolios. Thus, with positive SMB premium, smaller firms have larger expected returns than larger firms. In other words, the slopes on SMB decrease from smaller to larger portfolios. This is a result confirmed by da Silva (2004) who finds the SMB factor decreasing going from small to big for 5 portfolios sorted on size. Moreover, both Malaga and Securato (2003) and Fama and French (1993) find evidence of the same tendency.

Similarly, the HML factor proved statistically significant for 6 out of 9 portfolios at the 2.5 % level. Once more a clear pattern can be seen. Going from a low to a high book-to-market ratio the value of the coefficient increases, thus value firms are rewarded. In other words, the slopes on HML increase with the book-to-market ratio. The HML factor thus captures common variation left out by the market and SMB factors. Again this tendency is found in similar studies, da Silva finds that the HML coefficient decreases monotonically from his 5 portfolios sorted on the B/M ratio. Fama and French (1993) also confirm this result for all portfolios, while Malaga and Securato find no clear pattern. Thus, the approach with dependent sorting of the data produces coefficients that are more in line with the theory advocated by Fama and French.

5.1.4 The SMB model

The R^2 term was reduced in 8 out of 9 portfolios when the HML factor is left out of the regression, i.e., comparing the SMB to the three-factor model. Nevertheless, the R^2 is larger in 8 out of 9 portfolios when compared to the traditional CAPM. The largest increase is found in the SH portfolio where the R^2 increases from 0.15 to 0.61, a significant increase. The market factor, *b*, is yet again significant for all the portfolios. Moreover, the SMB coefficient

is now only insignificant in 1 portfolio, i.e., the BM portfolio, at the 10 % level. At the 5 % level it is significant in the six smallest portfolios.

Table 7

Regressions of excess stock returns on the excess market return (BOVESPA – Index) and the SMB factor between 1995-2006. 144 months*

$$R_{P_{it}} - R_{ir_t} = a + b\left[R_{m_t} - R_{ir_t}\right] + s\left[SMB_t\right] + e_{i,t}$$

b

Size	L	M	H
	Book/Market		
S	0,60	0,64	0,98
I	0,53	0,53	0,57
B	0,58	0,70	0,77

Pvalue (b)

Size	L	M	H
	Book/Market		
S	0,00	0,00	0,00
I	0,00	0,00	0,00
B	0,00	0,00	0,00

s

Size	L	M	H
	Book/Market		
S	0,66	1,12	2,09
I	0,35	0,36	0,42
B	-0,14	-0,08	-0,17

p(s)

Size	L	M	H
	Book/Market		
S	0,00	0,00	0,00
I	0,00	0,00	0,00
B	0,07	0,30	0,06

a

Size	L	M	H
	Book/Market		
S	-0,01	0,00	0,01
I	-0,01	0,00	0,01
B	-0,01	0,00	0,00

p(a)

Size	L	M	H
	Book/Market		
S	0,31	0,77	0,12
I	0,15	0,45	0,08
B	0,09	0,19	0,32

R square

Size	L	M	H
	Book/Market		
S	0,41	0,63	0,61
I	0,42	0,46	0,46
B	0,62	0,72	0,67

Average Absolutt Value (a)

Avg. Alfa	0,006

* RM is the market return measured by the BOVESPA market index. RF is the risk free rate measured by the the Interbank Certificate of Deposit (CDI) yield. The 9 size and book-to-market portfolios are formed as follows. All data are collected from the ECONOMATICA using quotations from the BOVESPA. Each year *t* between 1995 and 2006 the stocks are divided into 3 equally large groups sorted by size, i.e. market equity (stock price times shares) using data from December. Similarly, data for book value is collected from ECONOMATICA to calculate the book-to-market ratio. The book-to-market ratio is calculated using data from December in year *t-1*.The three size sorted groups are then sorted on book-to-market equity and the 9 equally weighted portfolios are constructed. The equally weighted portfolio returns are calculated from January through December in year *t*. The SMB factor is constructed using the 6 equal weight portfolios formed on size and book-to-market (not independently). SMB (Small Minus Big) is the average return on the three small portfolios minus the average return on the three big portfolios. Stocks with negative book value, not consecutive quotations and no market value are excluded for any given year.

Note that we find a negative relationship between firm size and the *s* coefficient. This implies that the small companies should have higher expected returns than the big companies. These results are supported by Malaga and Securato (2004) who find a similar pattern. Thus this result helps support the motivation of Fama and French (1993) that size is a proxy for a common risk factor that could explain the negative relationship between size and return. Further, the intercepts are not significantly different from zero in this two-factor model either, and the average of the absolute values of the intercepts is somewhat lower than in the CAPM model.

5.1.5 The HML model

Table 8 reports the result for the model incorporating the excess market return and the HML factor as explanatory variables. When comparing these results to the three-factor model results from table 6 we see that the R^2 terms are lower for all but two portfolios. However, as in the model incorporating the SMB factor above, this HML model explains more return variation than the CAPM model. The R^2 terms increase in 8 out of 9 portfolios although only marginally in most. For the SH portfolio however, the R^2 increases from 0.15 to 0.62.

Table 8

Regressions of excess stock returns on the excess market return (BOVESPA – Index) and the HML factors between 1995-2006. 144 months*

$$R_{P_{it}} - R_{ir_t} = a + b\left[R_{m_t} - R_{ir_t}\right] + h\left[HML_t\right] + e_{i,t}$$

		b				Pvalue (b)		
		Book/Market				Book/Market		
Size	L	M	H		Size	L	M	H
S	0,52	0,42	0,46		S	0,00	0,00	0,00
I	0,49	0,47	0,47		I	0,00	0,00	0,00
B	0,63	0,72	0,78		B	0,00	0,00	0,00
		h				p(h)		
		Book/Market				Book/Market		
Size	L	M	H		Size	L	M	H
S	-0,26	0,35	1,67		S	0,01	0,00	0,00
I	-0,17	-0,03	0,26		I	0,03	0,68	0,00
B	-0,25	-0,08	0,20		B	0,00	0,20	0,01
		a				p(a)		

	Book/Market		
Size	L	M	H
S	0,00	0,00	-0,01
I	0,00	0,00	0,00
B	0,00	0,00	0,00

	Book/Market		
Size	L	M	H
S	0,82	0,78	0,10
I	0,65	0,76	0,35
B	0,62	0,35	0,99

R square

	Book/Market		
Size	L	M	H
S	0,31	0,30	0,62
I	0,39	0,40	0,43
B	0,66	0,72	0,68

Average Absolutt Value (a)

Avg. Alfa	0,004

* RM is the market return measured by the BOVESPA market index. RF is the risk free rate measured by the the Interbank Certificate of Deposit (CDI) yield. The 9 size and book-to-market portfolios are formed as follows. All data are collected from the ECONOMATICA using quotations from the BOVESPA. Each year *t* between 1995 and 2006 the stocks are divided into 3 equally large groups sorted by size, i.e. market equity (stock price times shares) using data from December. Similarly, data for book value is collected from ECONOMATICA to calculate the book-to-market ratio. The book-to-market ratio is calculated using data from December in year *t-1*. The three size sorted groups are then sorted on book-to-market equity and the 9 equally weighted portfolios are constructed. The equally weighted portfolio returns are calculated from January through December in year *t*. R squared is adjusted for degrees of freedom. The HML factor is constructed using the 6 equal weight portfolios formed on size and book-to-market (not independently). HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios, Stocks with negative book value, not consecutive quotations and no market value are excluded for any given year.

We also get the now familiar result that the betas are significant in all the portfolios and that the intercepts cannot be expected to differ from zero. The average of the absolute values of the intercepts is marginally lower than in the CAPM here too. The HML factor is statistically significant in 7 out of 9 portfolios at the 5 % level. Moreover, we see that the HML coefficient decreases as the book-to-market ratio increases for each given level of size. This helps confirming the proposition by Fama and French (1993) that relative profitability might be the source of a risk factor that could explain the positive relationship between book-to-market ratio and return. These results are not supported by Malaga and Securato (2004) who find no pattern. Moreover, their HML slopes are only significant in 4 out of 9 portfolios.

Comparing these regression results the three-factor model explains most common variation in stock returns measured with the R^2 terms. At its extreme, the R^2 value increases by 0.63, from 0.15 to 0.78, compared to the CAPM. Compared to the three-factor model the two-factor models incorporating the SMB and the HML factors, respectively, do a poorer job explaining the returns. This does not, however, change the fact that they increase the ability to capture common variation in returns when compared to the original CAPM. The SML and HML (at

10 % level) models both increase the coefficient of determination in 8 out of 9 models. Based on these regressions we can support the proposition by Fama and French and conclude that both the SMB and the HML seem to be related to systematic risk factors not related to the market factor.

Compared to the previous Brazilian studies the results are somewhat ambiguous. The R^2 values are sometimes higher and sometimes lower than what find Malaga and Securato (2004). However, the R^2 values vary less between the portfolios, and the factor coefficients are in general more often significant. Most importantly, Malaga and Securato do not find a positive relationship between the B/M ratio and average return, a result predicted by Fama and French. Thus, we can conclude that the different approach to constructing the portfolios have improved the regression results somewhat. Da Silva (2004) runs regressions for size sorted portfolios and for B/M sorted portfolios, and finds the same pattern as Fama and French and this paper.

Nevertheless, the results found here are far from as convincing as those found by Fama and French (1993). The R^2 values are in general lower and the coefficients less significant. Thus, there might be hopes that incorporating world factors by extending the three-factor model to a six-factor model might improve the regression results.

5.2 The international six-factor model

The international factors' explanatory power of stock return variation will now be investigated using the model defined in equation (5). In addition to the factors from the domestic three-factor model above, the excess portfolio returns are regressed on the international excess market return as well as on the foreign SMB and HML factors.

In table 10 the results from the full six-factor model regressions are given. The R^2 values have increased for all portfolios compared to the domestic three-factor. At its extreme, the R^2 term increased from 0.5 to 0.57. On average, the R^2 terms seem to have increased by about 2-4 percentage points, a rather marginal increase. Nevertheless, the inclusion of foreign factors

is more important here than in Griffin (2002). He investigates the inclusion of foreign factors to a domestic three-factor model in Japan, U.S., U.K., and Canada and finds that the inclusion of foreign factors adds almost zero explanation to the regressions. They all contribute to less than a 0.005 increase in the R^2 terms. Compared to this, the inclusion of foreign factors is a great success in the Brazilian market.

The beta terms are statistically significant for data both from Brazil and the U.S. The U.S. excess market return coefficients are significant for all but one portfolio at the 5 % level. This leads to the conclusion that incorporating the foreign excess market return as an explanatory variable was a good idea. The average of the absolute values of the intercepts is 0,003 and there is no evidence to reject the 0-hypothesis that they are equal to zero. Thus, this measure too decreased somewhat, implying a better specified model.

Table 9

Regressions of excess stock returns on the excess market return (BOVESPA – Index) and the SMB and HML factors and on U.S. excess market return (NYSE, NASDAQ, Amex) and the U.S. SMB and HML factors between 1995-2006. 144 months*

$$R_{P_{it}} - R_{ir_t} = a + bd\left[D(R_{m_t} - R_{ir_t})\right] + sd\left[DSMB_t\right] + hd\left[DHML_t\right]$$
$$+ bf\left[F(R_{m_t} - R_{ir_t})\right] + sf\left[FSMB_t\right] + bf\left[FHML_t\right] + e_{i,t}$$

		db					p(db)		
		Book/Market					Book/Market		
Size	L	M	H		Size	L	M	H	
S	0,75	0,66	0,74		S	0,00	0,00	0,00	
I	0,61	0,58	0,55		I	0,00	0,00	0,00	
B	0,63	0,72	0,71		B	0,00	0,00	0,00	
		ds					p(ds)		
		Book/Market					Book/Market		
Size	L	M	H		Size	L	M	H	
S	1,09	1,21	1,41		S	0,00	0,00	0,00	
I	0,63	0,54	0,38		I	0,00	0,00	0,00	
B	0,04	-0,02	-0,34		B	0,66	0,81	0,00	
		dh					t(dh)		
		Book/Market					Book/Market		
Size	L	M	H		Size	L	M	H	

S	-0,66	-0,09	1,15	S	0,00	0,26	0,00
I	-0,39	-0,22	0,15	I	0,00	0,00	0,08
B	-0,25	-0,07	0,34	B	0,00	0,27	0,00

fb

	Book/Market		
Size	L	M	H
S	0,28	0,27	0,23
I	0,41	0,41	0,39
B	0,26	0,19	0,37

p(fb)

	Book/Market		
Size	L	M	H
S	0,03	0,01	0,13
I	0,00	0,00	0,00
B	0,00	0,03	0,00

fs

	Book/Market		
Size	L	M	H
S	0,15	0,16	0,09
I	0,19	0,16	0,25
B	0,15	-0,10	0,07

p(fs)

	Book/Market		
Size	L	M	H
S	0,33	0,24	0,62
I	0,14	0,20	0,07
B	0,17	0,39	0,59

fh

	Book/Market		
Size	L	M	H
S	0,16	0,07	-0,07
I	0,12	0,15	0,06
B	-0,07	0,02	0,07

t(fh)

	Book/Market		
Size	L	M	H
S	0,21	0,53	0,64
I	0,30	0,16	0,60
B	0,46	0,83	0,55

a

	Book/Market		
Size	L	M	H
S	0,00	0,00	-0,01
I	0,00	0,00	0,00
B	0,00	0,00	0,00

p(a)

	Book/Market		
Size	L	M	H
S	0,57	0,95	0,13
I	0,39	0,44	0,66
B	0,27	0,24	0,30

R square

	Book/Market		
Size	L	M	H
S	0,593	0,660	0,789
I	0,568	0,554	0,536
B	0,699	0,730	0,739

Average Absolutt Value (a)

Avg. Alfa	0,004

* RM is the market return measured by the BOVESPA market index. RF is the risk free rate measured by the the Interbank Certificate of Deposit (CDI) yield. The 9 size and book-to-market portfolios are formed as follows. All data are collected from the ECONOMATICA using quotations from the BOVESPA. Each year *t* between 1995 and 2006 the stocks are divided into 3 equally large groups sorted by size, i.e. market equity (stock price times shares) using data from December. Similarly, data for book value is collected from ECONOMATICA to calculate the book-to-market ratio. The book-to-market ratio is calculated using data from December in year *t-1*. The three size sorted groups are then sorted on book-to-market equity and the 9 equally weighted portfolios are constructed. The equally weighted portfolio returns are calculated from January through December in year *t*. The HML and SMB factors are constructed using the 6 equal weight portfolios formed on size and book-to-market (not independently). SMB (Small Minus Big) is the average return on the three small portfolios minus the average return on the three big portfolios. HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios, Stocks with negative book value, not consecutive quotations and no market value are excluded for any given year.

The U.S. Fama/French factors are constructed using the 6 value-weight portfolios formed on size and book-to-market. SMB (Small Minus Big) is the average return on the three small portfolios minus the average return on the three big portfolios. The portfolios, which are constructed at the end of each June, are the intersections of 2 portfolios formed on size (market equity, ME) and 3 portfolios formed on the ratio of book equity to market equity (BE/ME). The size breakpoint for year *t* is the median NYSE market equity at the end of June of year t. BE/ME for June of year t is the book equity for the last fiscal year end in t-1 divided by ME for December of t-1. The BE/ME breakpoints are the 30th and 70th NYSE percentiles. HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios, Rm-Rf, US, the excess return on the market in the U.S. is the value-weighted return on all NYSE, AMEX, and NASDAQ stocks (from CRSP) minus the one-month Treasury bill rate (from Ibbotson Associates). Rm-Rf includes all NYSE, AMEX, and NASDAQ firms. SMB and HML for July of year t to June of t+1 include all NYSE, AMEX, and NASDAQ stocks for which we have market equity data for December of t-1 and June of t, and (positive) book equity data for t-1.

The domestic SMB coefficients are statistically significant in 7 out of 9 at the 5 % level. Here too, we see that size of the coefficient decreases with the size of the companies, thus supporting Fama and French's proposition that size is negatively related to return. Only one foreign SMB factor is significant at the 10 % level.

For the HML factors the story is similar. The domestic factors are significant for 7 of 9 portfolios. The foreign HML factors do not have significant slope coefficients in any of the portfolios. As in the domestic model, the domestic HML factors follow the predicted pattern. A higher B/M ratio implies a higher return.

The international six-factor model provides some improvement in explanatory power compared to the domestic three-factor model since the R^2 terms are somewhat higher. This effect is driven almost entirely by the foreign market factors since 8 of the 9 foreign SMB and all foreign HML factors are insignificant. Thus, there are some advantages adding on foreign factors. The increase in the R^2 values is very large compared to those found by Griffin (2002), but they are only in the range of 0.01 – 0.07. Since the U.S. factors are readily available it should be straightforward to utilize them in practical applications of the model. However, caution should be taken reaching this conclusion as the U.S. factors are constructed using nominal data whereas the domestic factors are calculated with real numbers.

Both the three-factor and the six-factor model should be usable for practical purposes since their intercepts are very close to zero, indicating a good specification. As Fama and French (1993) say, the SMB and HML factors work "surprisingly well" in explaining common

variation in returns. These factors, that are rather arbitrarily constructed, together with the market return absorb more than 65 % of the variation for most portfolios. However, the R^2 values are low compared to those found in the U.S. market, thus the appeal of applying this model in Brazil is weakened.

6. Conclusion

The object of this paper has been to evaluate the performance of a domestic three-factor model and an international six-factor model in explaining variation of returns in the Brazilian market. The period chosen was 1995-2006 and the methodology strongly resembles that applied by Fama and French in the U.S. market, however with a different approach to constructing the portfolios.

The domestic three-factor model better explains variation of returns than the traditional CAPM. At its extreme, the coefficient of determination increased from 0.15 to 0.78. Compared to the results found by Fama and French the results found here are less convincing. The factors do not work as well explaining return variation in Brazil as in the U.S. Regarding the different approach to sorting the data the results are somewhat ambiguous compared to the paper by Malaga and Securato (2004). The R^2 terms are higher for some portfolios, lower for others. However, they are of more equal magnitude over the portfolios, thus the approach used here may be regarded to have a more stable prediction power than the approach of Malaga and Securato. The slopes on the SMB and HML factors are more often significant in this paper than in that of Malaga and Securato.

Moreover, the results here confirm the results of Fama and French that return is negatively related to size and positively related to the B/M ratio. This result is found in all regressions that uses the domestic SMB and HML factors as explanatory variables. We find a positive premium both for the SMB and HML factor. This is the result predicted from the theory of Fama and French. These patterns are found also by da Silva (2004), but, surprisingly, Malaga and Securato (2004) do not find this positive relationship between the B/M ratio and average return. Thus, the different approach to forming the portfolios have led to regression results more in line with those predicted by Fama and French.

Other results worth mentioning are that we find a negative relationship between size and average return and a positive relationship between the B/M ratio and average return when calculating descriptive statistics. These results are confirmed by Fama and French, but not by Malaga and Securato who find no patterns at all.

We find that the inclusion of foreign factors increase the explanatory power of the model somewhat. However, this effect is almost entirely due to the foreign excess market return. Nevertheless, the increase in the R^2 terms is larger in this paper than those found by Griffin (2002), i.e., some evidence is found that this approach works better in Brazil than in some of the developed markets. Caution, however, needs to be taken in interpreting this result since the world factors are constructed using nominal quotes whereas the Brazilian factors are constructed with real values.

An important question to answer is whether the three-factor model can be used in portfolio selection, performance evaluation and estimating cost of capital. However, this requires that the factors explain well the cross-section of average returns, an investigation that is not further pursued in this paper. Fama and French find that the SMB and HML factors explain well the cross-section of returns in the U.S. market while the market factor is needed to explain the average stock returns above the risk free rate. Thus, if this is also true in Brazil, the regression slopes and historical factor premiums can be used to calculate expected portfolio return. Moreover, the investor can target a specific level of expected return by choosing factor weights. Similarly, historical returns of a firm's securities can be used to calculate the expected cost of capital of the firm. Portfolio management performance is very easy to apply using this method since the portfolio manager gets a benchmark from the passive application of the three-factor model. If the historical returns of a fund manager generates a positive intercept using the models presented here, it is evidence that the fund manager outperformed the benchmark. Unfortunately, the appeal to using these models for these purposes in Brazil is reduced because of the relatively lower explanatory power compared to the U.S.. But, since there is a lack of other models and it explains most of the return variation it is probably one of the best models to apply for these tasks.

Important questions need still to be answered. Why don't the models capture all the variation of the stock returns? Is it the misspecification of the asset-pricing models or is it because of the inefficiency of the market? More comprehensive tests are needed in the Brazilian market, For example, conditional tests for efficiency on asset pricing models or for asset pricing models on efficiency. Further, is the market portfolio mean-variance efficient? Since all these

models depend on the CAPM, who again depends on this assumption, the interpretation of the results will be dubious if it can be established that the market portfolio does not satisfy this criterion. Moreover, no study incorporating bond returns as explanatory variables exists. Finally, theoretical explanations of the SMB and HML factor are still lacking, thus efforts trying to find the underlying state variables would be greatly appreciated.

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